

NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS

CIRCULAR 89



Fruit Rot of Pepper

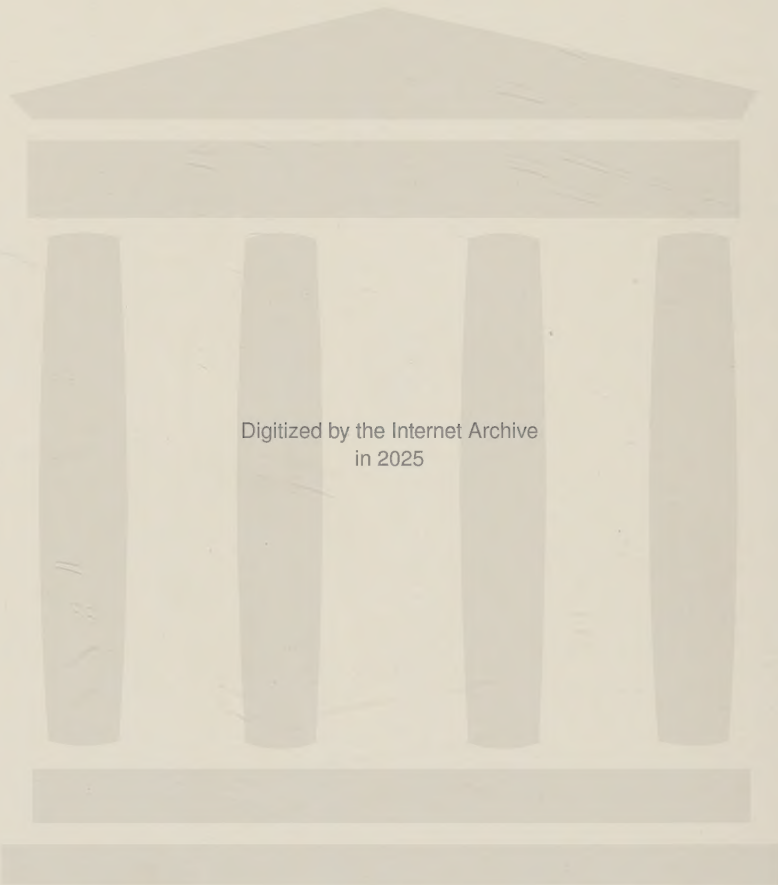
COMMON DISEASES OF GARDEN VEGETABLES

AND TRUCK CROPS

Mal. T. Cook.

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NEW JERSEY

AGRICULTURAL EXPERIMENT STATIONS

CIRCULAR 89

COMMON DISEASES OF GARDEN VEGETABLES AND TRUCK CROPS¹

Garden vegetables and truck crops are subject to many diseases and are the cause of so many inquiries addressed to the Agricultural Experiment Station, that it has been considered advisable to prepare this circular, giving brief descriptions of the diseases and treatments for them. Many of these diseases are caused by fungi, but some few are caused by bacteria. Many of them live on weeds related to our cultivated crops and are not recognized by the growers. Many of them live from year to year in the soil and on the old decaying plants of the last year's crop which very few growers make any effort to remove. Some of them thrive in the decaying stable manure which is used so extensively in the growing of these crops. These facts, and the fact that rotation is not practiced so extensively as with field crops, tends to perpetuate the diseases from year to year.

The *treatments* depend upon the character of the crop and also upon the character of the disease. Where possible to do so, it is advisable to practice crop rotation, but in some cases the price of the land is so high and the value of the crop for which it is adapted so large that rotation is impracticable. Under some conditions the use of commercial fertilizers instead of stable manure is advantageous; in some cases the use of lime will give good results and in other cases the sterilization of the soil is most satisfactory. In some instances the growers will find it most profitable to grow disease-resistant varieties. In some few cases the crops can be sprayed to advantage. These treatments will be discussed in connection with the diseases in question.

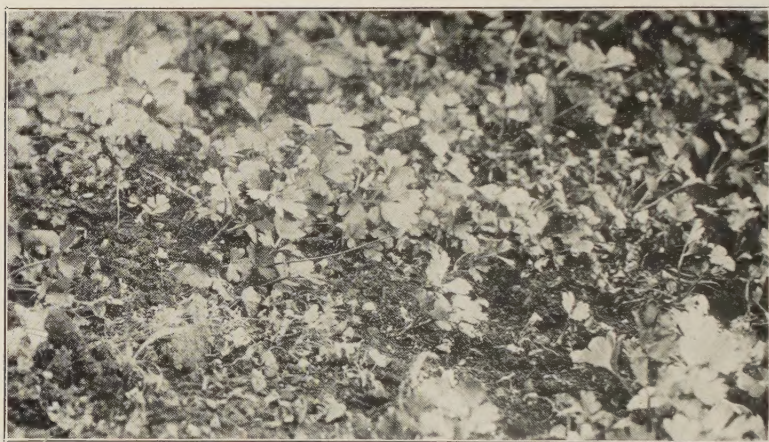
DAMPING OFF

This is a very general disease of many plants which may be due to any one of several fungous organisms (fig. 1). The most important ones in New Jersey are *Rhizoctonia* and *Fusarium* sp. but we also find that *Pythium de Baryanum* and other organisms may cause the disease. They attack the small seedlings at the surface of the soil causing them to wilt, fall and die. The attack frequently occurs in spots in the seed-beds and these infected areas

¹Prepared December 1, 1917, by Mel. T. Cook, Ph. D., Plant Pathologist, New Jersey Agricultural Experiment Station.

gradually increase in size. This disease is much more severe in rich soil, especially soil that has been highly manured, than in poor soil. This is due to the fact that these organisms live saprophytically on the decaying organic material, and when the conditions are favorable they attack the seedling plants. It is especially severe in greenhouses and cold frames that have received an excess of water or that are not well ventilated.

The most satisfactory precautions for the prevention of "damping off" of seedlings are: (a) soil sterilization (p. 19), (b) light sowing of seeds, (c) removal and destruction of diseased plants together with the soil in which they were grown, (d) careful ventilation, (e) avoiding excess of water, and (f) avoiding too sudden changes in temperature. Sometimes (g) the disease can be killed out by the application of hot sand to the infected area, and sometimes (h) it can be controlled by watering with weak Bordeaux mixture, but it should be applied carefully, or it may kill the young plants.



(Photo by R. F. Poole)

Fig. 1. Damping off of celery.

ASPARAGUS

ROOT ROT (*Rhizoctonia*). This disease has been reported to us a few times. Thus far it has not proved serious. The only satisfactory treatment to be recommended at this time is a rotation of crops and the use of healthy plants for starting new beds.

RUST (*Puccinia asparagi*). This common and well known disease causes a rust, spotting and dying of the plants. In localities where this disease is severe, it is advisable to grow the Palmetto or some other resistant variety.

Note. The United States Bureau of Plant Industry has developed some resistant strains, seed of which can be obtained on request.

BEANS

See Circular 50, New Jersey Agricultural Experiment Station, on "Diseases of Beans and Peas."

BEETS

HEART ROT (*Phoma beta*). This disease may attack the seedling plants and cause a "damping off", or it may appear later in the season, causing a blackening of the heart leaves followed by a spotting and dying of the older leaves. Frequently the disease is not sufficiently severe in the field to attract much attention, but it becomes severe in storage and causes a rapid black rot. The fungus causing the disease is carried over on the leaves in the field and is also probably carried on the seed. Crop rotation is the most satisfactory treatment.

LEAF SPOT (*Cercospora beticola*). This is the very common foliage disease of beets which appears as small brown spots with purplish borders (fig. 2). This disease can be controlled by spraying with Bordeaux mixture, but the treatment is very seldom used in truck gardening.



(Photo by R. F. Poole)

Fig. 2. Leaf spot of beet (*Cercospora beticola*).

SCAB (*Actinomyces chromogenus*). This is the same as potato scab (Circular 53, New Jersey Agricultural Experiment Station). Do not use beets in rotation with potatoes or turnips. Do not put beets on soil in which the disease is known to be present.

CABBAGE

BLACK ROT (*Pseudomonas campestris*). This is a bacterial disease which is very common in the state. The older leaves die and fall; they are yellowish in color and the veins tend to become black. The disease usually starts with the older leaves, and works into the stem and then into the center of the heads, causing them

to rot and give off a vile odor. Having once gained an entrance to the stalk, it very readily works its way outward into the healthy leaves. The disease also attacks cauliflower, kohlrabi, turnips, kale, rape and other cruciferous plants (see radish, p. 14).

The organisms causing this disease will persist in the soil and must be eradicated by crop rotation. The disease is carried in the seed which can be treated with corrosive sublimate (POISON) (1 part in 1000 parts of water) for 15 minutes, or with formaldehyde (1 part in 200 parts of water) for 20 minutes. Rinse in clean water and dry promptly.



(Photo by R. F. Poole)

Fig. 3. Club root of cabbage (*Plasmodiophora brassicae*).

YELLOWS (*Fusarium conglutinans*). This is a very severe disease which usually attacks the plants about two to four weeks after setting, but may attack them in the seed-bed. The outer or lower leaves turn yellow around the margins and between the veins, become brown or scorched in appearance, and finally drop. In some cases only one-half of the leaf is affected, the other half remaining normal. When the disease is well advanced we frequently find tall bare stalks with small imperfect heads at the tips. There is no pronounced rotting as in the case of the black rot.

The disease can be controlled (a) by seed treatment, the same as for black rot (b) by soil sterilization (p. 19), (c) by crop rotation, and (d) by growing resistant varieties.²

²Information concerning resistant varieties can be obtained by writing directly to the New Jersey Agricultural Experiment Station.

BLACK LEG, FOOT ROT OR WILT (*Phoma oleracea*). This disease may attack plants at any time during their growth, but is most common and severe on young plants. In fact it is a very important seed-bed disease. It starts on the stem at the surface of the ground and causes irregular sunken areas, or it may attack the margins, petioles and mid-ribs of the leaves. The spots increase in size and frequently cause death. It spreads downward and causes the roots to decay. The dying plants frequently show a purplish tint. The sunken areas show small black spots which are the fruiting bodies of the fungus.

The disease can be controlled (a) by seed-bed sterilization, (b) by spraying seedlings with Bordeaux mixture, (c) by crop rotation, and (d) by setting healthy plants. If the seed-bed is infected it is extremely difficult to secure healthy plants and it is usually desirable to destroy the entire lot.



(Photo by R. F. Poole)

Fig. 4. Club root of cabbage (*Plasmodiophora brassicae*)

CLUB ROOT (*Plasmodiophora brassicae*) (fig. 3 and 4). This very common disease causes an enlargement of the root system of the plants which results in a corresponding stunting of the parts above ground. It also attacks cauliflower, kohlrabi, radish and similar plants. It is rather difficult to eradicate the organism from the soil, but it can be done by a long crop rotation or by the application of burnt limestone at the rate of 90 bushels per acre. If possible, the lime should be applied six months before planting. Where possible to do so, it is advisable to combine these two

methods. Knowing that the field or garden is free from the disease, it is advisable to keep it clean. Therefore, the grower should use every possible precaution in selecting his plants to make sure that they are free from this and other diseases.

DOWNY MILDEW (See radish, p. 14).

WHITE RUST (See radish, p. 14).



(Photo by R. F. Poole)

Fig. 5. Early blight on celery (*Cercospora apii*)

CARROT

SOFT ROT (*Bacillus carotovorus*). This is a bacterial rot which also attacks turnips, salsify, radish, parsnip, onion, celery, rutabaga and other plants. The disease starts in the field but is most destructive in storage. It usually starts at the crown or root tip and works very rapidly along the central axis. It is a very soft rot, is somewhat slightly discolored and the boundary between the diseased and healthy tissue is well defined. Crop rotation should be practiced where the soil is known to be infected. Manures from stock which have been fed on diseased plants should not be used unless thoroughly dried. Drying and exposure to light kills this organism.

BLIGHT (*Macrosporium carotæ*). This disease occurs occasionally in the state and causes the tops to die and blacken. It can be controlled by spraying with Bordeaux mixture.

CAULIFLOWER

The diseases of cauliflower are the same as the diseases of cabbage (p. 5).

CELERY

EARLY BLIGHT (*Cercospora apii*) (fig. 5). This is the most severe disease of celery in New Jersey. It starts as brown spots which become large and numerous, causing the leaves to turn yellow, wilt and dry. It is especially severe during wet, cloudy weather. It also occurs on wild parsnips and some other related plants. It is probably carried from season to season in the soil and in the decaying leaves which are left on the field. It can be controlled by frequent spraying with Bordeaux mixture applied under high pressure.



(Photo by R. F. Poole)

Fig. 6. Late blight on celery (*Septoria petroselini* var. *apii*).

LATE BLIGHT (*Septoria petroselini* var. *Apii*) (fig. 6). This very common disease causes rusty brown spots on leaves and stems which are usually smaller than the early blight spots. Although the cause of heavy loss, it is not so destructive in New Jersey as the early blight. The control is the same as for early blight.

ROTS. There are several rot diseases attacking the crown, heart and roots of this crop in both seed-beds and in the field. In the seed-beds they can be very readily controlled by soil sterilization. These diseases are the subject of special studies and field treatments which are being conducted at this time by the New Jersey Agricultural Experiment Station. The results of this work will be published later.

CHARD

LEAF SPOT (*Cercospora beticola*). Same as on the beet (p. 5).

CRESS

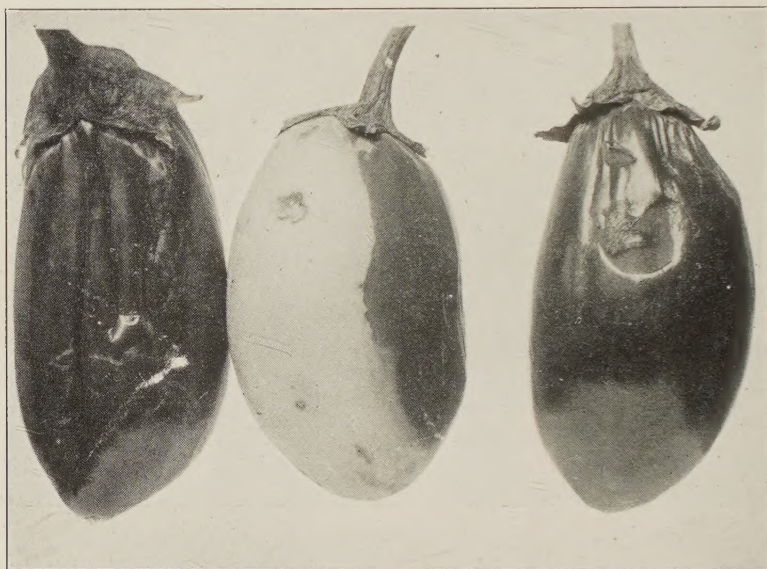
DAMPING OFF (See p. 3).

CUCUMBER

See Circular 68 on "Diseases of Cucumber and Melons", New Jersey Agricultural Experiment Station.

EGGPLANT

WILT (*Bacillus solanaccanum*). This is a southern disease which is of very little importance in New Jersey; but there is another disease, apparently due to a fungus, which causes considerable loss. It is not well understood and must be the subject of future study. It will persist in the soil from year to year.



(Photo by R. F. Pool.)

Fig. 7. Fruit rot of the eggplant (*Phomopsis vexans*).

ROOT ROT (*Thielavia basicola*). This disease is rather frequent in New Jersey. It causes a black rotting of the roots and is frequently accompanied by the formation of numerous small roots, which in turn have the same rot. It also attacks many other plants, such as alfalfa, sweet peas, violets, tobacco, etc. Care should be taken to use healthy plants and to avoid susceptible crops for planting in soil known to contain the organism of disease.

WHITE RUST (See radish, p. 14).

DAMPING OFF (See p. 3).

FRUIT-ROT, LEAF SPOT, STEM-BLIGHT (*Phomopsis vexans*) (fig. 7). This is a severe fungous disease which attacks all parts of the plant above ground. The *leaf spots* are brown, circular or oblong, becoming irregular with age, most abundant near the margins

and along the large veins. The centers become grayish and the margins almost black. The *fruit-rot* starts with grayish to tan-colored blotches which develop into a soft rot, frequently spreading to the entire fruit. The blotches frequently become dry and black. The *stem-blight* form is most common on seedlings, in which case it may be described as a damping-off. This disease is difficult to control, but spraying with Bordeaux mixture will tend to hold it in check.

LETTUCE

LETTUCE DROP OR ROT (*Sclerotinia libertiana*). This is the most serious disease of lettuce. It starts with the lower leaves which droop and fall flat to the ground and have the appearance of being water-soaked or scalded with very hot water. It moves rapidly up the plant which dies within a very few days. It also spreads very rapidly to other plants. The pulling and burning of the plants as soon as the disease is detected will help to hold it in check. Crop rotation and soil sterilization are the most satisfactory treatments (see p. 18, 19). It will also attack celery, cucumber, radish and other plants. (Fig. 8 and 9).



(Photo by R. F. Poole)

Fig. 8. Lettuce drop (*Sclerotinia libertiana*).

GRAY MOLD (*Botrytis cinerea*). This disease is somewhat similar to the drop. It begins at the margin of the leaves, causing them to wilt and die. After death they become covered with the yellowish downy growth of the fungus. The control is the same as for lettuce drop. When it occurs under glass a lowering of the temperature and increased ventilation will tend to hold it in check.

DOWNY MILDEW (*Bremia lactuce*). This disease is sometimes troublesome under glass and is also found on outdoor plants. It causes downy leaf spots with a downy fungous growth on the under surface. It can be held in check by good cultural conditions and by careful ventilation.

LEAF SPOTS (*Septoria lactucae* and *S. consimilis*) and LEAF PERFORATIONS (*Marsonia perforans*) are sometimes troublesome, especially on older plants.

DAMPING OFF. (See p. 3).

MUSKMELON

See Circular 68 on "Diseases of Cucumbers and Melons", New Jersey Agricultural Experiment Station.



(Photo by R. F. Poole)

Fig. 9. Lettuce drop (*Sclerotinia libertiana*).

MUSTARD

BLACK ROT. (See cabbage, p. 5).

CLUB ROOT. (See cabbage, p. 7).

WHITE RUST. (See radish, p. 14).

OKRA

WILT (*Verticillium albo-atrum*). This is a fungous disease which attacks the plants of any age, causing them to wilt and die. The leaves fall, leaving the dead and partly dead stalks. Cutting the stem reveals black discolorations. Rotation is the only known remedy.

ONION

MILDEW (*Peronospora schleideniana*). This disease has occurred in various parts of the United States, but has not been reported from New Jersey. In its early stages the tips of the young plants show a furry, violet-colored growth. These diseased leaves become pale in color, moldy and finally collapse. Old plants are more susceptible than young plants. The disease can be controlled by frequent sprayings with Bordeaux mixture.

MOLD (*Macrosporium sp.*) has been found occasionally. The tips of the infected plants are dead and black. It is of very little importance and is probably secondary to some other trouble.

ROT (*Botrytis sp.*). This is a disease of minor importance which is occasionally found in the fields. Soft, bacterial rots are sometimes troublesome.



Fig. 10. Mosaic on pepper.

SMUT (*Urocystis cepulae*). This fungous disease appears as black spots on the leaves and bulbs; the spots on the leaves split and the leaves wilt. The spots on the bulbs are distinctly visible beneath the skins. The spots on both leaves and bulbs are filled with a black powder (spores of the fungus) some of which finds its way into the soil where it will live until the following year. When this disease is found the grower should practice crop rotation. It can also be reduced by using 2 parts of sulfur, and 1 part of lime by weight in the drill row, or by the use of formaldehyde (1 pound in 50 gallons of water) in the drill row (see p. 20).

BRITTLE (Cause?). This is a peculiar disease of the seedling onions which has been found in but one locality. The diseased plants are dwarfed, brittle and the tips very much curled.

PARSNIPS

EARLY BLIGHT (*Cercospora apii*). Same as the early blight of celery (p. 9).

PEA

See Circular 84 on "Common Diseases of Beans and Peas," New Jersey Agricultural Experiment Station.

PEPPER

ANTHRACNOSE OR ROT (*Colletotrichum nigrum*). This very common fruit rot is sometimes the cause of rather heavy losses. It is most severe on sunburnt fruits. Very little effort is made to control it, but the most satisfactory treatment is spraying with Bordeaux mixture.

MOSAIC (Cause not known) (fig. 10). This is the same as the mosaic of the tomato. It causes a peculiar mottling of the leaf; tends to reduce the vigor of the plant and also reduces the yield.

SUN SCALD. This is very common on large sweet peppers. The sunburnt fruits are very susceptible to rot organisms.

POTATO

See Circular 53 on "Potato Diseases in New Jersey," New Jersey Agricultural Experiment Station.

PUMPKIN

See Circular 68 on "Common Diseases of Cucumber and Melon," New Jersey Agricultural Experiment Station.

RADISH

CLUB ROOT (see cabbage, p. 7).

WHITE RUST (*Cystopus candidus*). This very common disease attacks all the parts of the plant above ground causing small white blisters which break and permit the escape of a white powder (the spores of the fungus). In severe cases it causes a deformity of the infected parts. It also attacks turnips, mustards, cress and other related plants. It is not considered of sufficient importance to necessitate the use of control measures.

DOWNY MILDEW (*Peronospora parasitica*). This is a common fungous disease of the radish and related plants and is often associated with the white rust. The fungus appears as a downy white growth on the under-surface of the leaves and sometimes on the stems. The upper surface of the leaves show pale yellow, angular spots, limited by the veins. The diseased plants should be destroyed.

BLACK ROT (*Pseudomonas campestris*) (fig. 11 and 12). This is a bacterial disease which is the same as the black rot of the cabbage. It is not so prominent on the leaves of the radish as on

the leaves of the cabbage, but it works its way down into the root causing a very pronounced rot. (See cabbage, p. 5).



(Photo by R. F. Poole)

Fig. 11. Black rot of radish (*Pseudomonas campestris*).

SPINACH

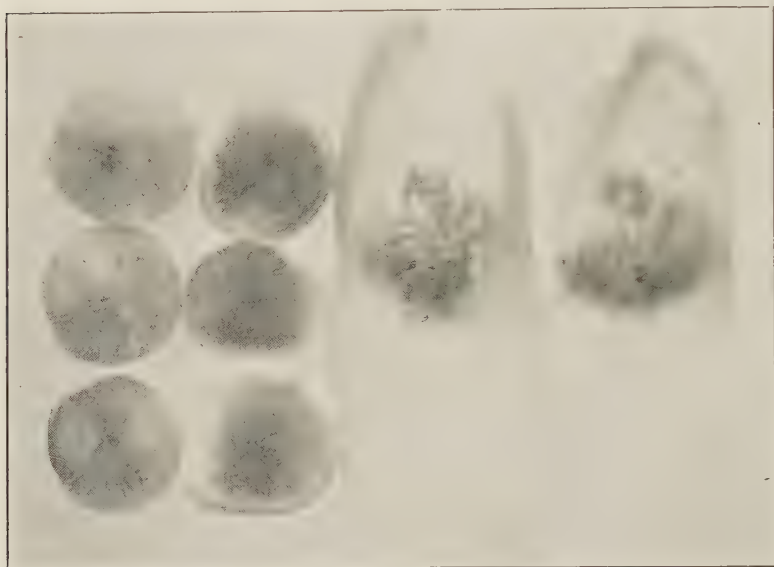
DOWNY MILDEW (*Peronospora effusa*). This is a very severe fungous disease of spinach grown under glass. It causes grayish, sometimes slightly violet-colored spots which tend to become brownish on the lower surface of the leaves, accompanied by pale yellowish spots on the corresponding parts of the upper sur-

faces. The fungus is carried over on the dead leaves, which become mixed with the soil.

The fact that the infected parts of the plants are used for salads makes spraying undesirable. If all of the old soil can be removed and new soil used the disease can be eradicated. The old soil can be used if sterilized (p. 19).

SQUASH

See Circular 68 on "Common Diseases of Cucumber and Melon," New Jersey Agricultural Experiment Station.



(Photo by R. F. Poole)

Fig. 12. Black rot of radish (*Pseudomonas campestris*).

SWEET CORN

SMUT (*Ustilago zeæ*). This very common disease of corn causes large black powdery masses on the ears, tassels and leaves. It is more severe on sweet corn than on field corn. It lives over in the old stalks, in the soil and in the manure from animals where it is used for feed and bedding. It can be held in check by rotation of crops and by avoiding manures from animals fed on diseased stalks.

WILT (*Pseudomonas stewartii*). This disease, which is very common on sweet corn, causes the plants to wilt and in severe cases to die. In extremely mild forms the plant may show very

little evidence of the disease. It is carried in the seed, and seed from slightly infected plants will carry and produce the disease the following year. Always select seed from healthy plants.

OTHER DISEASES. There are a number of other minor diseases of corn.

TOMATOES

See Circular 71, on "Diseases of Tomatoes," New Jersey Agricultural Experiment Station.

SWEET POTATOES³

BLACK ROT (*Sphaeronema fimbriatum*) is one of the most common and widespread diseases of the sweet potato. It attacks the under-ground parts of the plant. On the roots it starts as more or less circular spots, which spread and sometimes envelop nearly the entire root. The surface of the spot is black and the tissue just beneath the skin is black or has a greenish tint. The disease spreads in storage and sometimes causes heavy losses. If the diseased roots are cooked they have a bitter, disagreeable taste. Diseased seed roots will very naturally give rise to diseased plants in the seed-beds. It can usually be detected on the young plants by the black, rotten areas or cankers.

Control. Prepare the seed-bed according to instructions on page 19. In getting the soil for the seed-bed, the upper six inches of soil should be removed and the subsoil used. Rich soil is not necessary for the sweet potato seed-bed. Manures should be avoided, especially if the livestock have been allowed to feed on sweet potatoes. The seed potatoes and the young plants should be very carefully selected. Crop rotation should be practiced.

STEM ROT, YELLOW STEM OR STEM WILT (*Fusarium batatatis* and *F. hyperoxysporium*) is also very common and very destructive. The diseased plants are weak and of poor color and in severe cases die long before the time for digging. Those that do not die, produce small roots which are frequently used for seed the following year. If the stem of a diseased plant is split, the inner fiber will be found to be yellowish or black. This discoloration sometimes extends for three or four feet or more along the stem and also back into the roots.

Control. The seed-bed should be prepared as described on pages 19-21. The seed potatoes should be selected at the time of digging and from none but healthy, vigorous plants. In the spring they should be treated just before bedding in corrosive sublimate (POISON) (1 ounce in 8 gallons of water) for 5 to 10 minutes, or in formaldehyde (1 pound in 30 gallons of water) for 15 minutes. They should then be rinsed in clear water before bedding.

³A more extended discussion of the diseases of the sweet potato will be found in Farmers' Bulletin 714, which can be obtained by writing to the United States Department of Agriculture, Washington, D. C.

SCURF, RUST OR SOIL STAIN (*Monilochaete infuscans*). This disease occurs as a dark or rusted area, and covers more or less of the entire surface of the potato. It is superficial and easily scraped off. It does not injure the qualities of the potato but does reduce its market value. It can be controlled by the treatment recommended for stem rot.

WHITE RUST (*Albugo ipomoea-panduranae*) and LEAF SPOT (*Phyllosticta batatis* and *Septoria bataticola*) are common foliage diseases which are of little importance.

STORAGE ROTS are due to a number of causes. They are as follows: (1) The BLACK ROT (p. 17) frequently spreads in storage and causes heavy losses. (2) The SOFT ROT (*Rhizopus nigricans*) starts at the end of the potato and spreads rapidly. The so-called ring rot is due to the same cause as the soft rot, but starts in the middle of the potato. (3) The TRICHODERMA ROT (*Trichoderma koningi*) is very similar to, but less destructive than the preceding soft rots. (4) The DRY ROT (*Diaporthe batatis*) starts at the ends of the potato and causes a firm dry brown rot. (5) The CHARCOAL ROT (*Sclerotium bataticola*) is a dry black rot of comparatively little importance.

The control of these storage house rots is largely a problem of storage house management. The storage house should be heated to about 80° or 85° F. during digging and for about two weeks following. During this time the ventilation should be so arranged as to permit the easy escape of moisture. The temperature should then be gradually lowered to about 50° to 55° F. and maintained at that point throughout the season.

TURNIP

BLACK ROT. (See cabbage, p. 5).

CLUB ROOT. (See cabbage, p. 7).

DOWNY MILDEW. (See p. 14).

WATERMELON

See Circular 68, "Common Diseases of Cucumbers and Melons," New Jersey Agricultural Experiment Station.

TREATMENTS

Crop Rotation

The organisms which cause many of our plant diseases are carried from year to year in the soil. But many of these diseases are restricted to certain crops, some of them attacking only one crop and some of them attacking two or more crops. Therefore, it is advisable to practice rotation of crops as far as possible. In planning these rotations, the fact that certain diseases attack several crops must be taken into consideration.

Potatoes, beets and turnips are all susceptible to the common scab and should not be used in the same rotation.

Cabbage, cauliflower, turnips and radishes are all susceptible to black rot, club root and other diseases in common and should not be used in the same rotation.

Potatoes, tomatoes, and peppers are subject to several diseases in common and therefore should not be used in the same rotation.

Cucumber and melons are subject to several diseases in common and accordingly should not be used in the same rotation.

Lettuce, cucumbers and celery are subject to *Sclerotinia libertiana* and should not be employed in the same rotation.

Celery and parsnips are both subject to early blight (*C. apii*) and therefore should not be used in the same rotation.

Sanitation

It is well known that many diseases are carried over on roots, leaves and stems of the plants of the previous year. When a disease has been severe on any crop, it is sometimes advisable to rake and burn the dead plants. However, it is impossible to destroy all the fragments of the old plants and therefore, crop rotation also should be practiced.

Manures and Fertilizers

Manures are the most desirable fertilizers for most crops but are sometimes the source of very destructive diseases. Many growers throw diseased and decaying plant materials on the manure heaps, from which they are returned to the soil. Litter which has been used for bedding for livestock is frequently thrown on the manure heap and thence carried to the soil, thus carrying the diseases back to the land; corn smut is very frequently carried in this manner. The organisms of some diseases will pass through the alimentary canals of animals and then grow very readily. Therefore, the practice of using manures from animals that have been fed on diseased plants such as decaying roots and smutted grain is very likely to result in the outbreak of serious plant diseases. In growing some plants, such as sweet potatoes, it is desirable to use nothing but commercial fertilizers. Lime and ashes should not be applied to the soil before planting potatoes, beets or turnips, as they are favorable to the production of common scab.

Seed-beds and Soil Sterilization

Seed-beds and cold frames should be prepared with the greatest care in order to prevent the infection of young plants before setting. In most cases, manures are used in seed-beds and cold frames, but the fact that certain diseases are carried in this way and that damping-off organisms thrive in them makes it desirable to use nothing but commercial fertilizers in some cases, especially in the growing of sweet potato plants. (Of course, when the commercial fertilizers only are used, it is sometimes necessary to use artificial heat.) It is advisable to put the seed-beds or cold frames in a new place each year if possible but if this is not done the old soil should be removed and the wood work carefully sterilized, or both soil and wood work sterilized. If the soil is removed, care should be taken that it is all removed and carried to a considerable distance. Small amounts of soil left in the beds are frequently sufficient to perpetuate the disease. If the soil is not carried away

from the bed, small particles are likely to be returned to the bed on the implements or on the workers' feet or hands. The wood work of the seed-beds should be thoroughly drenched with hot water or a solution of formaldehyde (1 pound to 20 gallons of water). If the old soil is used or if there is any reason to suspect new soil of being infected, it should be sterilized with steam or formaldehyde.

Soil sterilization is usually used in seed-beds, cold frames and green-houses, but is sometimes used on soil in the open. The most common methods are the use of formaldehyde and of steam. The soil to be treated should be loose and moist.

The formaldehyde solution (4 pounds of formaldehyde to 50 gallons of water) is applied at the rate of 1 gallon to each square foot of soil surface. In case the soil is very loose it may be necessary to make the application slowly over several hours, otherwise the liquid will run through very quickly and be lost. The soil should not be stirred during the treatment. Immediately after treatment the soil should be covered with burlap, old carpet, fertilizer bags or paper for two days. It should then be aired for ten days or two weeks and during this period should be stirred thoroughly three or four times.

Caution. If the soil is not thoroughly aired after treatment, the seeds may be injured and not germinate well. Do not add manure or other soil to the sterilized soil; it may carry organisms of disease. Be sure that the work tools are clean; they may carry disease organisms. The workman should not step into the bed after the soil is sterilized; the soil on his shoes may carry organisms of disease.

The most general method for steam sterilization is known as the inverted-pan method. The pans can be made of No. 22 galvanized sheet iron or pine lumber. For out-door work they should be made about 6 x 10 feet. They are attached to a boiler of 15 horsepower or more by means of a common 1-inch garden hose which connects with a nipple in the center of the pan. The edges of the pan should be pushed down into the loose soil and weighted. The steam should then be turned on and the temperature held at 200° or 250° F. for about one hour in order to get the best results.

Caution. The same precautions should be observed as for formaldehyde sterilization. Also, it must be remembered that this treatment cannot be used satisfactorily on shale soils or any other soil that tends to pack. Sometimes the first crop on soil subjected to high steam sterilization does not thrive, but the second crop is usually satisfactory.

Clean Implements

The diseases that persist in the soil can be very readily carried on farm implements and also on the feet of the workmen and work animals. Therefore, it is frequently advantageous to take precaution to prevent infection of clean soil in this way.

Some diseases such as black rot of cabbage and bean anthracnose are carried on the work tools during the growing season. If these diseases are present the crops should not be cultivated or harvested when wet from dew or rain, and the tools should be thoroughly cleansed or disinfected before using them on another crop which is susceptible to this same disease.

Seed Treatments

Many diseases are carried on seed and some of them can be controlled by seed treatment. Seed potatoes can be treated for common scab and *Rhizoctonia*; sweet potatoes can be treated for rots; cabbage and cauliflower seeds can be treated for black rot and some grains can be treated for smuts.

Seed Selection

Some diseases can be avoided or held in check by seed selection. The seed should be selected from healthy plants that yield a product of the size and quality desired. The anthracnose of the bean may be reduced by hand-picking the dry seed before planting.

Selection of Healthy Plants

In the growing of cabbage, sweet potatoes, tomatoes and similar plants which are first grown in the seed-bed and then transplanted to the field or garden, the grower should use every possible precaution in the selection of the plants. Diseased seedlings mean diseased plants in the field and, in the case of many of these diseases, may mean the infection of the soil with organisms that may require two or more years of treatment to eradicate.

Spraying

Spraying can be used for the control of many foliage and fruit diseases of garden and truck crops. If the crop is grown on a large scale, large traction or power sprayers should be used, but small hand sprayers are suitable for gardens. The most satisfactory spray material for most diseases that can be controlled in this way is Bordeaux mixture. The method of preparation is given in Circular 48 of the New Jersey Agricultural Experiment Station. The strength of the solution will vary with the plants to be treated. It is sometimes desirable to spray the seedlings in the seed-beds. Tomato seedlings can be sprayed with a weak solution (about 2-3-50) of Bordeaux mixture. The addition of 3 pounds of resin fish-oil soap to each 50 gallons of the mixture is advantageous. Stronger solutions can be used on seedlings grown in the open than on those grown under glass.

Spray mixtures should be applied with a sufficiently high power to produce a very fine mist. The under as well as the upper surface of the foliage should be covered if possible. Paris green or arsenate of lead for killing insects can be added to the Bordeaux mixture without injuring either material.

ADDITIONAL CIRCULARS

The following circulars on plant diseases will be of interest to the growers of garden and truck crops. They can be obtained by writing direct to the Agricultural Experiment Station, New Brunswick, N. J.

- No. 48. Bordeaux Mixture.
- No. 53. Potato Diseases in New Jersey.
- No. 68. Common Diseases of Cucumbers and Melons.
- No. 71. Diseases of Tomatoes.
- No. 84. Common Diseases of Beans and Peas.

